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On the $4f^2 5d \rightarrow 4f^3$ interconfigurational transitions of Nd^{3+} ions in K_2YF_5 and $LiYF_4$ crystal hosts

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Abstract

The Laser Induced Fluorescence (LIF) spectrum of K_2YF_5:Nd^{3+} (PFYK:Nd) and $LiYF_4$:Nd^{3+} (YLF:Nd) single crystals, pumped by the fluorine F_2 pulsed discharge molecular laser at 157.6 nm, was obtained in the Vacuum Ultraviolet (VUV) region of the spectrum. The fluorescence peaks were assigned to the $4f^2 5d \rightarrow 4f^3$ dipole allowed transitions of the Nd^{3+} ion. The 180 nm band of the LIF spectrum from the crystals indicates that the $4f^2 5d \rightarrow 4f^3$ dipole transitions originate from the low Stark components of the $^4K_{11/2}$ level of the $4f^2 5d$ configuration. The absorption spectrum of the crystal samples in the VUV was obtained as well and spectroscopic assignment of the levels of the $4f^2 5d$ configuration was made. The electric crystal field splits all the levels of single and mixed configuration. The energy of the Stark components of the $4f^2 5d$ configuration in YLF:Nd was shifted by few hundred cm^{-1} relative to that of PFYK:Nd. We observed eleven and nine dipole transitions, between the $^4I_{9/2}$ ground level of the $4f^3$ configuration and the Stark components of the levels of the $4f^2 5d$ configuration of the Nd^{3+} ion, in YLF and PFYK crystal hosts, respectively. © 1998 Elsevier Science B.V.

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1. Introduction

The Vacuum Ultraviolet (VUV) and Ultraviolet (UV) absorption and excitation spectroscopic characteristics of the rare-earth (RE) ions [1–3] activated in the wide band gap of fluorine dielectric crystals are either due to transitions from the levels of the $4f^n$ single configuration of the trivalent lanthanide ion to the levels of the $4f^{n-1}5d$ mixed configuration (where a 4f electron is promoted to a 5d localized level), or from transitions from the occupied valence bands formed by the $P(F^-)$ orbital in the fluoride host compound. The $4f^n \rightarrow 4f^{n-1}5d$ transitions are characterized by strong Frank–Condon factors and they are responsible for the broad-band absorption and emission spectra in the VUV and UV. In contrast, the intraconfigurational $4f^n \rightarrow 4f^n$ transitions are parity forbidden. These transitions are forced by crystal field configuration mixing and they appear to be weaker and sharper. In addition to the above mentioned processes responsible for transitions in the VUV and UV, the fluorescence could be due to transitions from electron transfer of the filled molecular orbital, delocalized on the ligands and terminating in the partly filled 4f orbital or the valence band [4]. The use of VUV radiation to excite a common RE impurity in different dielectric fluorine hosts allows one to study the excita-

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